

History and Functions of Botanic Gardens with Special Reference to Singapore

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MANY PEOPLE THINK of botanic gardens as public parks in which to stroll amid pleasant surroundings and admire beautiful and rare flowers. Others consider them a convenient exercising ground for the baby or the dog, a good place for picnic and, in Singapore, somewhere to feed the monkeys.

Definition of Botanic Gardens

Any public park can provide these amenities. Why then go to the expense of maintaining botanic gardens with their staff of botanists, horticulturists and other specialists? The answer is that botanic gardens, to merit the name, are gardens maintained for the scientific study of the plants. As soon as this vital function is neglected botanic gardens change to public parks. This has been the fate of many botanic gardens throughout the tropics, while others have been totally neglected or have disappeared. It is true that they sometimes sell or give away planting material of fruit trees and ornamental plants, but this function can be undertaken by agricultural stations or commercial nurseries.

Botanic or Botanical

Some gardens such as Kew and Singapore are proud of the name Botanic Gardens, all too frequently called Botanical Gardens by the public, while others, especially in America, style themselves Botanical Gardens. Why is this? Botanic is the older form of adjective, but is now mostly superseded by botanical, except in the names of institutions founded long ago. It is advisable to ascertain which adjective is used by any particular gardens in order not to give offence. Some such as the Royal Botanic Garden, Edinburgh, do not use the plural of the noun.

The first Botanic Gardens

The oldest botanic gardens in existence today are those of Pisa in Italy founded in 1543, closely followed by Padua. They were founded by the Universities and were herb gardens in which the

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future physician was taught the medicinal use of herbs and how to recognize them. The Jardin des Plantes was founded by Louis XIII in Paris for this same purpose in 1626, as was the Oxford Botanic Gardens by the University in 1632, and the Chelsea Physic Garden in 1673 by the Apothecaries Society.

Systematic study of plants

In the eighteenth century Linnaeus laid out a garden showing his new system of classification and the plants were labelled in accordance with his binomial nomenclature. Other gardens followed suit and were designed to illustrate a purely scientific concept. Living plants, as well as herbarium specimens, were brought from all over the world for study in temperate countries. Botanists were often attached to voyages of exploration to collect and bring back this material. Many of the famous gardens of Europe, including the Kew Royal Botanic Gardens, founded in 1759, carried out these early taxonomic studies. (The first Botanic Gardens in the United States were not founded until the nineteenth century.) The herbaria and libraries which are so essential for this work were accumulated and the systematic study of plants, sometimes on a local basis, sometimes on a world basis, is still one of the most essential functions of modern botanic gardens.

Founding and work in the early tropical Gardens

As far as I can ascertain the oldest botanic gardens in the tropics are those of Pamplémousses in Mauritius which were established by the French in 1735. Hart's (1919) history of these gardens makes fascinating reading and is typical of many tropical gardens elsewhere. They started as a pleasure garden, although cassava was first introduced as early as 1736. After periods of neglect their principal function was to obtain, grow and distribute seeds of economic plants, particularly of spices, hitherto only cultivated by the Dutch in the Moluccas. Nutmegs were first introduced in 1765, but died. Among the introductions in 1767 were pepper, cinnamon, fruit trees and other plants yielding dyes and varnishes. Expeditions in 1770 and 1772 brought back nutmegs and cloves. The gardens were laid out in a picturesque manner and planted with native, African, Indian, Malayan and Australian plants. They suffered from subsequent periods of neglect, but later played a prominent part in the founding of the Mauritius sugar industry. They were taken over by the newly-formed Agricultural Department in 1913.

The first British tropical botanic gardens are those of St. Vincent founded in 1764 (Chipp, 1920). Bligh was commissioned to obtain bread-fruit for these gardens from Tahiti and his expedition

ended in the famous mutiny of the *Bounty* in 1787; he was more successful in 1791 and brought back bread-fruit plants to the West Indies. These gardens were abandoned for some 60 years later in their history. Among the other early botanic gardens founded in colonial territories are Jamaica in 1774, Calcutta in 1786, the first of the three Penang Botanic Gardens in c.1796, Buitenzorg (now re-named Bogor) in 1817; Trinidad in 1819, Peradeniya (Ceylon) in 1821 and the first Singapore Botanic Gardens in 1822. Typical of all these gardens is the founding of the first botanic gardens in the north American continent when Charles III of Spain sent a scientific expedition to Mexico in 1781, when "one of its objects was to establish a botanic garden in which instruction should be given in botany and in which the native products of the country should be cultivated and preserved" (Rickett, 1956).

In addition to the very important function of collecting, growing and distributing indigenous and exotic economic crops of promise, as well as seedlings of timber trees, and giving advice to the early planting communities on methods of cultivation and the control of pests and diseases, many of these botanic gardens laid a sound foundation of botanical research in the tropics in the nineteenth century. Many of the early directors were men of outstanding ability and industry. First and foremost they were keen botanists and could not help but be interested in the wild plants growing around them, many of which were as yet undescribed. They made arduous collecting trips into little-known country bringing back living plants for trial in their gardens, as well as large numbers of herbarium specimens. These were exchanged with other institutions throughout the world, and as time went on local floras and monographs of particular groups were prepared. The world owes these great pioneers a considerable debt.

By the second decade of the twentieth century most tropical territories had inaugurated independent agricultural and forestry departments, and much of the work on crops and forest products was handed over to them. Many of the botanic gardens were absorbed into the new agricultural departments, often with disastrous results to the research in botany which they had hitherto undertaken. The rôle of botanic gardens in fostering agricultural development in many tropical countries, usually achieved with very small staff and slender financial resources, is now often forgotten.

The movement of crops in the tropics

I have already shown how botanic gardens played a prominent rôle in the distribution of the principal economic crops grown today in the tropics. It is worth examining the subject a little further. It

has always seemed strange to me that many of the world's major tropical plant products are produced largely in countries far removed from their region of origin, e.g. South American rubber in Malaya and Indonesia, South America cocoa in West Africa, South American quinine in the East Indies, African coffee in Brazil, cloves and nutmegs from the Moluccas in Zanzibar and Grenada respectively, sugar, bananas and limes from South-East Asia in the West Indies, and vanilla from Central America in Madagascar. Obviously this cannot be attributed to any one particular reason and many factors are involved, including economics, available land and labour supply, technical skill in processing, suitability of the crop for plantation or peasant agriculture, etc. Nevertheless, one would have expected that a crop was more suited ecologically to its country of origin than to its new home. I suspect that one of the major reasons is that when a new crop has been introduced without many of its normal pests and diseases, it has more chance of flourishing and giving high yields. Many of the crops are introduced as seeds, which limits the number pests and diseases which they can carry with them, and this is further enhanced by the plant quarantine regulations now enforced in many countries. One can only contemplate what would happen to the Malayan rubber industry if the South American Leaf Blight (*Dothidella ulei*) were accidentally introduced.

In this digression I have limited myself to economic crops, but further examples can well be given from food crops, too. Many of the staple crops now grown in parts of tropical Africa are of New World origin, e.g. cassava, sweet potatoes and maize.

The early Penang Botanic Gardens

Ridley (1910a) gives the date of the founding of the first Botanic Gardens, Penang as 1800, although in the same article he states that, soon after the first settlement in Penang in 1786, the East India Company decided to start spice gardens with a view to breaking down the Dutch monopoly of the spice cultivation and trade. A botanist, Christopher Smith, was appointed in 1794 and in 1796 was sent to the Moluccas to collect living plants of nutmegs and cloves. Ridley then adds that by 1800 the Gardens contained 1,300 plants and that they were greatly enlarged in that year, when 15,000 clove and 500 nutmeg trees arrived from Amboina. It thus appears that the first Gardens were begun about 1796 and not in 1800 as is usually stated. Ridley goes on to say that Smith sent in all 71,266 nutmeg plants, 55,264 cloves and large quantities of canary nut, (*Canarium commune*) and Kabong palm, (*Arenga saccharifera*).

This transporting of very large quantities of plants in the tropics was to continue throughout the nineteenth century. Nor was the movement confined to economic crops, as plants of horticultural merit were freely distributed between botanic gardens, while scientific institutions, wealthy patrons, seedsmen and nurseries sent collectors to the far corners of the earth to bring back novelties for their hothouses and for sale. The scale on which the exchanges took place is hardly conceivable today and the expense, difficulty and length of time spent transporting them must have been very considerable.

The first Penang Botanic Gardens were sold in 1806. Raffles founded the second Gardens in Penang in 1820. Ridley states that these existed until 1834, "when Governor Murchison, who took no interest in gardens or agriculture, sold them for 1,250 rupees, because his wife could not get enough vegetables from them to diminish her cook's bill."

HISTORY OF THE SINGAPORE BOTANIC GARDENS

The Singapore Botanic Gardens are the last gardens in the British tropics which function as a separate and self-contained department and have never been under the control of any Agricultural Department, Municipality or University. I now propose to confine my attention to these Gardens and describe some of the work carried out there during their long history.

The first Singapore Botanic Gardens

Shortly after the founding of Singapore in 1819, the founder, Sir Stamford Raffles started the first Botanic Gardens on the Government Hill at Fort Canning in 1822. Nathaniel Wallich, who was visiting Singapore from the Calcutta Botanic Gardens, advised on this project. Raffles introduced nutmegs, cloves and cocoa. These gardens were closed in 1829 on instructions from India to retrench expenditure. They were re-opened later by an Agri-Horticultural Society in 1836, who covered the cost from the sale of nutmegs and cloves growing there. They were finally abandoned about 1846. The principal crops of Singapore at that time were nutmegs and gambier; the former failed because of pests and diseases; the latter was too exhausting to the soil and required large quantities of charcoal for its preparation.

In a recent popular article in a Singapore paper a writer (H.T.S., 1956) says, "When critics carp at British colonialism, they should stop for a moment and ponder on the old circumstance that one of

the first matters which occupied the earnest attention of the founders of Singapore was to find a site for a botanical (*sic*) gardens. No great plan for exploiting the local people was afoot here."

The Second Singapore Botanic Gardens

The First Phase: 1859–1875

In 1859 a new Agri-Horticultural Society was formed in Singapore, the third in the history of the island. The Society was given a grant of some 60 acres of land in Tanglin by the Government on which to found a garden. Convict labour was also provided. Members of the society paid an entrance fee and a monthly subscription, while there were second-class subscribers who might enjoy the use of the gardens by paying a monthly fee. They also raised money by public entertainments. The southern end of the Gardens was probably abandoned gambier land, a haunt of tigers, while the north was still virgin tropical evergreen rain forest, 11 acres of which are still preserved in their original form, a most valuable asset in the centre of a great city. The first object of the committee was to create a pleasure garden with roads, terraces and a band stand, where military bands performed fortnightly, the gardens providing an alternative evening drive to the Esplanade for 'the quality'.

Laurence Niven, who supervised a privately-owned adjoining nutmeg plantation, was employed part-time as Superintendent. He had a fine eye for design and laid out the Gardens much as they are today. As early as 1861, flower shows were organised in the hope of encouraging the local cultivation of vegetables, fruits and flowers. In 1866 the Society purchased a further 25 acres of land and built the present Director's house, as well as constructing the Gardens' lake. This depleted the Society's funds and in 1869 they approached the Government for a further grant, the first being \$50 towards Niven's salary in 1866. The second grant was agreed to on condition that the Society should exhibit in the gardens living economic plants. At the same time a small zoo started. (There has been a menagerie at the Jardins des Plantes in Paris since 1794.) By 1874 the Society was in debt and could carry on no longer. They asked the Government to take over their Gardens and their debts and to maintain the Gardens for the benefit of the people of Singapore. Government agreed to do this and in 1875 the management committee asked Sir Joseph Hooker, the Director of the Royal Botanic Gardens, Kew, to recommend a suitably trained candidate for the post of Superintendent, who "was to be a practical, as well as systematic botanist, and to travel in the Malay Peninsula not a little for the purpose of investigating its vegetation". (Burkill, 1918).

Thus the second Singapore Botanic Gardens, which celebrates its centenary in 1959, originating as a little more than a public park, began the second phase of its history and was changed into a working Botanic Garden.

The Second Phase: 1875–1888

Sir Joseph Hooker sent out James Murton, a Kew trained horticulturist. He was energetic and enthusiastic, but unfortunately was very young and little suited for control. He added greatly to the collection of plants growing in the Gardens, both economic and horticultural, from the principal Botanic Gardens in the East, as well as Kew. Kew sent the first live Para rubber seedlings in 1877 (see below).

Under the Raffles Society Ordinance of 1878 the Gardens were legally taken over by the Government of the Colony and vested in Her Majesty the Queen, her Heirs and Successors. In 1879 the Government allocated a further 102 acres of land, now occupied by the University of Malaya, for the cultivation of economic crops, particularly gutta-percha and rubber-producing trees. Also growing in these Economic Gardens at this time were *Cinchona*, arabica and liberica coffee, *Eucalypti*, *Ipecacuanha*, tea, maize, sugar cane, cola nuts, mahogany, etc. Murton added greatly to the Gardens' menagerie. He collected plants in Singapore and in the Peninsula, but his duplicates in Singapore later disappeared, when he was dismissed in 1880. He died in Bangkok the following year and Burkill (1918) says "his death perhaps hastened by his having burnt the candle at both ends."

Murton was succeeded by Nathaniel Cantley, who was also a Kew trained horticulturist. He had been Assistant Superintendent of the Mauritius Botanic Gardens and was an older man, a great lover of order. He did much planting and named and labelled all the plants in the Gardens. He surveyed the forests of the Straits Settlements and was responsible for gazetting the first forest reserves. He planted large numbers of Malayan and introduced timber trees in the Economic Gardens, and his arboretum was arranged in a botanical sequence on the system of Bentham and Hooker. Cantley was a keen botanist; he collected local plants and started the herbarium. He also experimented with European vegetables. The grounds of Government House Domain were placed under the Botanic Gardens and still remain so today. The Gardens also helped in horticultural work in the city and much of the tree planting in Singapore, which greatly adds to its attraction, was supervised by the Gardens' staff. Cantley, who had never been a very fit man, went on sick leave in December 1887 and died the following year.

The Third Phase: 1888–1912

With the appointment of Henry Nicholas Ridley as Director in 1888 the Gardens entered upon the third stage in their history and a most productive period it was. "Ridley's capability as a research worker and his power to demonstrate by his publications the practical and beneficial effects of photography on plant science in all its aspects . . . succeeded in a surprisingly short time in pushing the Singapore Gardens to the fore as a centre of Malaysian phyto-graphy" (de Wit, 1949). Ridley was a tireless worker and his phenomenal output of work in the natural sciences and his application of this to economic problems is quite remarkable.

He has been rightly named "the father of Malaya's rubber industry". His early experiments on the tapping and preparation of rubber and his constant advocacy of it as a plantation crop, often in the face of opposition, led to the foundation of the present industry upon which so large a share of the wealth of Malaya and the eastern tropics has rested (Purseglove, 1955 a). Nor was his work on economic crops confined to rubber; he carried out experiments with most of the actual and potential crops known. As early as 1889 he reported that cacao would probably be profitable on the better Malayan soils, while in 1907 he directed attention to the possibility of oil palm as a plantation crop. The local planting community was largely dependent upon the Economic Gardens for planting material and seeds of economic crops were distributed to all parts of the tropics. In the case of rubber alone, over seven million seeds were distributed from the Singapore Botanic Gardens, as well as many seedlings. The Gardens obtained a considerable income from the sale of these, as well as the rubber produced, thus allowing them to be maintained without any increase in Government vote. Visitors from all over the world visited the Economic Gardens, while Ridley and his three assistants in Singapore, Malacca and Penang, were the only trained men whom the planting community could approach for technical advice and help. It was Ridley who was responsible for and then administered, the *Coconut Trees Preservation Ordinance* of 1890 for the control of the rhinoceros beetle. In addition to being Director of the Botanic Gardens, Ridley was also Director of Forests, Straits Settlements and was responsible for gazetting additional forest reserves. He produced the first published accounts of Malayan timbers, vegetables, fruits, fibres, dyes and drug plants, while his book on *Spices* (1912) is the standard work.

Ridley's work as a field botanist is equally remarkable. He travelled far and wide in the Malay Peninsula, often in remote regions,

as well as visiting Cocos and Christmas Islands, Borneo, Java and Sumatra. On all these expeditions he studied the vegetation and brought back vast numbers of herbarium specimens, as well as many living plants for trial in the Gardens. In all he collected many thousands of specimens, of which a large number were unknown to science. These specimens are now in our herbarium, but duplicates were sent to Kew and other botanical institutions. He named and described for the first time a few thousand plant species and a surprising number are still only known from his original gatherings. Specimens were sent to experts on certain groups elsewhere and many new species were named in his honour. Ridley realised very early in his career that the flora of a country cannot be studied *in vacuo* and that it is essential to take into account plants from neighbouring territories as well. After his retirement he wrote his five-volume *Flora of the Malay Peninsula* (1922–25).

Nor was Ridley's attention confined to plants, of which he collected in all groups. He belongs to that great pre-specialised age of scientific natural history and he collected and studied many animals, as well as distributing specimens and writing about them. Ridley's work as a naturalist has been more fully described elsewhere (Purseglove, 1955 b). He took a keen interest in the Gardens' menagerie, which was disbanded in 1904–5, much to Ridley's obvious regret.

In addition to publishing in many scientific journals in Singapore and overseas, Ridley founded the *Agricultural Bulletin of the Malay Peninsula* in 1891, so that he could supply the planting community and others with information resulting from his many investigations. In all he published over 500 papers, articles and books, totalling over 10,000 printed pages, so that the work of the Singapore Botanic Gardens became widely known throughout the world. Details of his publications and other work will be found in *Gardens' Bulletin*, Vol. IX, 1935, which was dedicated to him on his 80th birthday. Attention should be drawn, however, to his encyclopaedic volume, *The Dispersal of Plants throughout the World*, published in 1930, which still contains much of value for the botanist and the agriculturist.

Few people have accomplished so much in twenty-three years of tropical service as Ridley did—he retired in 1912—nor have completed their work after retirement as he had done. He was elected a Fellow of the Royal Society in 1907 and, apart from the honour of C.M.G. in 1911, he received comparatively little public recognition, until his hundredth birthday, which was celebrated on the 10th December, 1955. On this occasion he wrote "It is a great delight to me to have lived to see the Gardens, the best tropical

Gardens in the world," and that "my hundredth birthday was one of the most enjoyable days of my life". It is with regret that I record the death of Mr. Ridley on the 24th October, 1956.

The founding of Malaya's rubber industry

Accounts of the transfer of Para rubber from Brazil to the eastern tropics have often been given, but frequently they are inaccurate in detail. As the Singapore Botanic Gardens played such an important part in this introduction, it is worthwhile recording briefly the facts at this juncture.

Sir Clement Markham of the India Office, who had been responsible for bringing *Cinchona* from South America to the east in 1865, pointed out in 1870 that there was a danger of exhausting the Indo-Malaysian supply of wild rubber and recommended that plantations should be put down in the east. James Collins, who was Government Economic Botanist and Librarian in Singapore, was asked to collect all the available information about rubber-producing plants and his report was published in 1872. Through Markham's efforts and those of Sir Joseph Hooker, the Director of Royal Botanic Gardens, Kew, a few seeds were collected and sent to Kew in 1873, when a dozen plants were raised. Six of these were sent to the Calcutta Botanic Gardens and were later propagated and sent to Sikkim, where they were a failure, the climate being unsuitable. A consignment of seeds was sent to India in 1875 and failed to germinate.

Markham then arranged for Robert Cross to collect rubber seeds in South America, while Hooker obtained the services of H. A. Wickham, later Sir Henry, who was then on the Amazon. Wickham collected 70,000 seeds. He did not smuggle the seeds out as is often suggested; it is now known that they were brought out with the goodwill and co-operation of the Brazilian Government. Wickham chartered a ship and the seeds arrived at Kew on 15th June, 1876, where they were planted immediately. Less than 4 per cent germinated and some 2,800 seedlings were raised at Kew. Many large tropical oily seeds retain their germination powers for short periods only and it was Ridley who later discovered that they could easily be transported in damp powdered charcoal. On 9th August, 1876 Kew sent 1,919 plants to Ceylon in 38 Wardian cases. Two days later 50 plants were sent direct from Kew to Singapore. Thiselton-Dyer (1878), and later quoted by Ridley (1910b), states that "owing to the delay in payment of freight (in Singapore) these plants all perished". Burkill (1935) says that Murton reported that "five plants were alive when the cases were received at the Gardens", although they appeared to have perished subsequently.

On 10th June, 1877 Kew sent a further 22 plants direct to Singapore and these thrived. They were not sent from Ceylon as is often published.

In the meantime Cross returned to England with a consignment of plants in November, 1876. Burkill (1935) states that "not one of Cross's plants collected in Para is known to have survived the seedling stage or to have reached the east". This was good fortune in disguise as the east was stocked from Wickham's seeds, which were collected in the central valley of the Amazon, where the trees are now known to have been of better quality than those nearer the mouth. Murton planted eleven of the rubber plants near our present nursery and then Fox in 1879 transferred them to swampy ground in the new Economic Gardens, as it was thought that this was the natural habitat of the tree. He took nine of his seedlings to Perak in October 1877 and these were planted at the Residency at Kuala Kangsar. Most of the rubber in Malaya has come from this original introduction, although some seeds were received from Ceylon at a later date.

The Singapore trees first fruited in 1881. When Ridley arrived in 1888, there were 9 trees of the original introduction, some 50 trees 2-4 years old and over 1,000 young seedlings. He quickly planted more. The subsequent exploitation and establishment of rubber as a plantation crop in Malaya was due almost entirely to Ridley. Within four months of his arrival in Singapore he drew the Government's attention to this possibility. With great perseverance, little encouragement or help and slender financial resources, he set to work. He has since recalled how he was "carpeted by the Governor, Sir Frank Swettenham, who admonished him to waste less time on an uneconomic product such as rubber." He experimented with various rubber-producing trees and found that *Hevea* was superior to all others. Starting with a mallet and chisel, and later using a modified farrier's knife, he developed the tapping technique which has been but little changed since. He discovered wound response, which he terms "calling the rubber", and he also demonstrated that the bark regenerated and could be tapped again. He exhibited coagulated rubber in Singapore in 1890 and the following year sent specimens to England which were well reported on.

Having shown that rubber was a commercial proposition, Ridley then tried to persuade the reluctant planters to give the new crop a trial, but at first met with little success, as coffee was considered to be the only important crop in Malaya. For his efforts he was known as "Mad Ridley". In 1893 he distributed the plants and seeds to Residents and District Officers in the Federated Malay States to plant near their houses. It was fortunate for Malaya that

when rubber planting began in earnest—coffee prices had slumped and the trees had been attacked by diseases and pests—that there was at the Singapore Botanic Gardens a good supply of planting material and Ridley, the expert, with the latest 'know-how' to advise and to help planters. Ridley stayed long enough in Singapore to see the great rubber boom in 1910 and for Malaya to reach a pre-dominant position in world rubber production, which it has never lost.

The Fourth Phase: 1912–41.

During Ridley's term of office the Gardens established for themselves an international reputation, which was adequately maintained during the next stage in its history. With the forming of the new Agricultural Department in 1904, much of the work on the economic crops passed from the Gardens and the Economic Gardens were finally closed in 1925. Gradually during the period more staff were recruited, especially botanists, so that the work on taxonomy could be extended. Some work was done on the lower plants, particularly the Fungi. In the horticultural field the hybridising of orchid and other cultigens was undertaken.

I. H. Burkill, who had been on the staff of the Calcutta Botanic Gardens and had collaborated with Watt on the study of the economic products of India, was appointed Director in Singapore in 1912. During World War I the Gardens were understaffed and there was little time for expeditions and collecting. Anderson's *Catalogue of Plants growing in the Gardens* was published in 1912 and lists 1739 species, which included 276 orchids, 261 ferns and 245 palms. T. F. Chipp was appointed Assistant Director in 1915, a new post having been created, but he did not take up his duties until 1919. He was transferred to West Africa at the end of 1920, in which year he published his *List of the Fungi of the Malay Peninsula*. Until the Economic Gardens were taken over by Raffles College, now the University of Malaya, in 1924–25, they continued to play an important role in the distribution of economic plants. In 1916 two hundred species were listed as available for sale at the Gardens. The loss of the Economic Gardens was a grievous blow, as the land available for planting was more than halved.

Burkill continued his interest in medicinal and economic plants generally and collected much information on these in Malaya. He continued this work for 10 years after retirement and published in 1935 his large two-volume *Dictionary of the Economic Products of the Malay Peninsula*, a work of great scholarship, "a masterpiece of synthesis", and a model for all works of this type. It is of great value to the botanist and the agriculturist, not only in Malaya, but

throughout the tropics. Unfortunately it is now out of print, but I hope that it may be reprinted soon. Burkill also made a detailed study of the genus *Dioscorea* (yams), a genus on which he is still working.

The Gardens Committee ceased to have their own banking account in 1919 and their balance was paid into the Treasury. Thereafter the Government increased the Gardens' vote, which was provided under several separate heads, where formerly a lump sum had been given.

R. E. Holttum was appointed Assistant Director in 1922. He was promoted Director in 1925 and continued in this post until 1949, when he became the first Professor of Botany in the University of Malaya. Holttum's principal interest were ferns and monocotyledons and he added greatly to our knowledge of these plants, describing many new species. He showed that wild orchids may hybridise and produce 'species' which had hitherto never been suspected to be of hybrid origin (de Wit, 1949). He began work in 1928 on the production of spectacular new free flowering hybrids of cultivated orchids and this work is still being continued at the Gardens.

C. X. Furtado joined the staff in 1923 and is still Botanist here. During this period he has become an acknowledged authority of the International Rules of Botanical Nomenclature and on Malaysian palms and aroids.

M. R. Henderson was appointed Curator of Herbarium in 1924 and held this post until he was appointed Assistant Director in 1946 and Director in 1949. He worked on Malayan flowering plants generally, his special interest being limestone plants and the family Myrtaceae.

E. J. H. Corner arrived in Singapore in 1929 as Assistant Director, the post which he held until 1946. He specialised in Fungi and trees and carried out research on the morphological and ecological aspects of the vegetation. Corner trained *berok* or pig-tailed monkeys (*Macacus nemestrina*) to collect botanical specimens, thus partly solving the problem of obtaining specimens from tall trees and climbers otherwise inaccessible. Corner states that one of these monkeys knew the meaning of 18 words of Malay and was able to find at the tree tops fruits and flowers which had been shown to him on the ground. It has been said that these botanical monkeys were "the first apes to enter Government Service". Corner's two-volume *Wayside Trees of Malaya* was published in 1940, a work full of out-of-the-way information and original observations and is one of the most fascinating books ever produced on the trees of

any country. Corner, now Lecturer at Cambridge University, is continuing his study of the genus *Ficus* in Malaysia.

Mention must also be made of C. E. Carr, a Malayan planter, who worked in conjunction with the Gardens, and added greatly to our knowledge of Malaysian orchids. He died in New Guinea in 1936 when returning from a collecting expedition.

From 1923 to World War II the senior staff of the Gardens consisted of Director, Assistant Director, Curator of the Herbarium and Assistant Botanist, all actively engaged on botanical research and three horticulturists as Curators, two in Singapore and one in Penang. In Singapore one Curator supervised the horticultural work at the Gardens and the other looked after Government House Domain and the outside commitments in the City.

The Gardens' collection of living plants and the herbarium were added to greatly during this period.

The Fifth Phase: The Japanese Interregnum: 1942-46

During the early years of the World War II before the Japanese attacked Malaya at the end of 1941, most of the senior Garden staff were seconded for at least part of their time to the Department of Food Control and Information. The Gardens maintained demonstration plots of vegetables to encourage local production. J. C. Nauen and G. H. Addison, Curators at Penang and Singapore, were mobilised with the local defence force and were later taken prisoners and sent to work on the Siam-Burma railway, where Nauen lost his life. Holttum, Corner and Furtado remained in Singapore during the occupation and were permitted to carry on with their botanical research. Immediately following the capture of Singapore Island, Professor Tanakadate, of Tohoku University, took over the control of the Gardens, and took care that they were not despoiled by the Japanese military forces. Holttum remained in executive charge until the appointment of Professor Kwan Koriba, of Kyoto University, as Director of Gardens in December 1942.* During his stay in Singapore Koriba undertook research on the growth-behaviour of some Malayan trees. It was particularly fortunate for the Singapore Botanic Gardens that the Japanese scientific officers and the British staff who remained were able to preserve the herbarium and the library as part of the cultural heritage of Malaya and that no loss whatsoever was suffered in them, except for a few specimens which were on loan in Germany. Losses did occur, however, among the living collection and garden work deteriorated generally, as more than half of the out-door staff (49 men)

* An obituary of Professor Kwan Koriba is published in this Bulletin.
Editor.

were sent to work on the Siam-Burma Railway, where 22 of them lost their lives. There was comparatively little damage in the Gardens, although the Director's house received a direct hit from a shell, but, even so, the damage was not serious.

From September 1945 to March 1946 the Gardens came under the British Military Administration.

The Sixth Phase: 1946-56

After the war the staff was gradually re-assembled, but did not reach its full compliment until the end of 1954, M. R. Henderson was appointed Assistant Director and later Director (1949-54). J. Sinclair arrived in 1948 as Curator of the Herbarium, the title later being changed to Keeper. J. W. Ewart, Horticultural Curator, served as Agricultural Officer, Singapore, as well as carrying out his duties at the Gardens. Henderson retired in 1954 and J. W. Purseglove was appointed Director, while H. M. Burkill (son of I. H.), was appointed Assistant Director in December of that year.

Gradually during this period the Gardens were brought back to their former good condition, the living collection of plants was increased and collecting in Malaya and Borneo was resumed. The first two volumes by R. E. Holttum of the *Revised Flora of Malaya* were published. Burkill has begun a study of Malayan seaweeds.

On the 10th December, 1955, the Gardens celebrated the hundredth birthday anniversary of H. N. Ridley, with an exhibition of Ridleyana and current work, while the Gardens were floodlit for one week. A special brochure for private circulation was produced for the occasion (Purseglove, 1955c).

Early in 1955 a scheme was drawn up in conjunction with the University of Malaya with the aim of attracting research workers from Britain and elsewhere to Singapore for one or two years to carry out the botanical research in their specialised fields. By this means the output of research would be increased and knowledge would be obtained which would be of great value to the tropics as a whole. Furthermore, workers from temperate countries would become familiar with tropical botany and their interest in our problems would be stimulated. In 1955 P. B. Tomlinson of Leeds University was awarded an Agricultural Research Council Scholarship and spent one year here studying the anatomy of palms. T. C. Whitmore, a Ph.D. student of Cambridge University, arrived in December 1956 to spend a year working on the anatomy of Dipterocarp barks in relation to taxonomy. He is receiving a Colonial Development and Welfare grant. It is hoped that more research workers may come in the future.

[In order to bring this paper up-to-date as a history of the first hundred years of the Botanic Gardens, the footnote below headed: **The Seventh Phase: 1957 and on**, has been added to the original paper in concurrence with the author.—EDITOR.]

Waterfall Garden, Penang

The third Botanic Gardens in Penang were founded by Charles Curtis in 1884 as "a nursery for the planting of colony products", and were under the charge of the Gardens and Forest Departments Straits Settlements, with its headquarters at the Singapore Botanic Gardens. Curtis, who had been employed as Messrs. Veitch's plant collector in Mauritius, Madagascar and Malaysia, was appointed Superintendent and remained there until his retirement in 1903. Holttum (1934) records that Curtis "was an enthusiastic plant-lover and a born gardener, and the development of the Waterfall Garden is a monument of his energy and skill". Curtis also made large collections of herbarium specimens in Northern Malaya. The Penang herbarium was later incorporated with that at Singapore.

The Seventh Phase: 1957 and on.

The penultimate constitutional step in the introduction of full internal autonomy of Singapore (effected in May 1959) was operative from April 1955. As befits a country in charge of its own affairs, the Singapore Government adopted a policy of "malayanisation" of the public service from January 1st, 1957. J. W. Ewart retired in March 1957 in accordance with this policy, and A. G. Alphonso, who had returned in 1956 from a two year course of training in horticulture at the Royal Botanic Gardens, Kew, England, was promoted Curator. J. W. Purseglove retired voluntarily in March 1957, and H. M. Burkill became Director. G. H. Addison retired in February 1959. Chew Wee Lek was appointed Botanist in 1956 and went to Cambridge, England, in 1957 for three years to study for a higher degree. Lam Hin Cheng was appointed Horticultural Assistant in July 1957 and went to the Royal Botanic Gardens, Kew, for a two year course in horticulture. The new post of Librarian was eventually filled in April 1958, and Tan Kim Ho went to Melbourne, Australia, in 1959 for training in library management on an Australian Government award under the Colombo Aid Programme. Attempts to fill the post of Assistant Director were unavailing, and finally Miss Chang Kiaw Lan was appointed Botanist (vice Assistant Director) to take up a study of mycology. In 1958 Bajuri bin Sappan, Laboratory Assistant, was sent to various institutions in England for one year to study plant breeding techniques with a view to furthering the Department's plant breeding work.

The last three years, 1957 to this centenary year of 1959 have been a period of transition characterised by an acute shortage of senior personnel through loss of qualified staff and temporary loss of the services of officers sent overseas for training. The most severe effects of this will be over by the end of 1959, when only one officer remains overseas, and he will be back in 1960. Thus will close a century of expatriate know-how in the senior botanical and horticultural posts, and there will open the second century of the Gardens' history, every bit as promising in the comity of international botany as the first has been successful, with the majority of the senior posts held by Malayan personnel. *H.M.B.*

In 1910 it was decided to convert the Gardens into a reservoir, but fortunately this did not materialise. With the formation of the Malayan Union in 1945, later renamed the Federation of Malaya, and the separation of Singapore as an individual colony, the control of the Waterfall Gardens passed from the Singapore Botanic Gardens to the Federation Agricultural Department. This was a great loss to the Singapore Gardens as the climate of Penang is more seasonal than that of Singapore and was therefore better suited for the growth of certain plants, which flower and fruit there, but will not do so in Singapore. Furthermore, the Penang Gardens lost the stimulus of direct contact with the parent institution where botanical research is carried out.

THE WORK OF BOTANIC GARDENS

The principal work carried out by botanic gardens can be divided under three broad heads, namely, botanical, horticultural and educational, although inevitably there is some overlapping between them. In addition to these functions most botanic gardens are opened to the public and thus provide the facilities of a public park. For this purpose they should be laid out as attractively as it is possible to make them, without jeopardising the work of the scientific study of plants. The Singapore Botanic Gardens are opened to the public from 6 a.m. until 7 p.m. daily; no charge is made and the popularity of the Gardens can be gauged from the very large number of visitors to them. Most tourists visiting Singapore also come to see the Gardens.

I now propose to give a more detailed account of the work under the various heads given above, illustrating this from the Singapore Botanic Gardens.

BOTANICAL WORK

The living collection

A botanic gardens should have as large a collection of living plants as it is possible to grow, without sacrificing an attractive layout. In fact a Gardens should be a great museum of living plants. All the plants should be correctly labelled with their scientific name and family, together with the country of origin. If there is a common English or vernacular name, this may be added, but this is often difficult when various languages are spoken as in Singapore. Care should be taken to keep the names up-to-date according to the latest nomenclature changes. As many different groups of plants as possible should be represented. Inevitably, certain gardens specialise in certain groups, particularly those on which specialists have

been working. Thus in Singapore our collection of palms, orchids and ferns are particularly good. Inevitably many plants of botanical interest, but of little value horticulturally, must be included in a botanic gardens, and they are not always as colourful as the layman expects. It is desirable that closely related species or even groups, should be planted near each other, which is very useful for comparative purpose, but this should not be carried to the extreme, as it results in a deterioration in the lay-out. Herbs and woody plants of varying stature, although belonging to the same family, are often difficult to grow together and to maintain and are unsightly when so planted. A lot of plants can be grown in pots. For this a burnt earth-compost mixture has proved to be the most suitable for our conditions for many plants. This method is described by Holttum (1953 a).

The Singapore Botanic Gardens have some 3,000 perennial species growing in them at present and this does not include hybrids. Even so, there is a limit to the number of plants that can be grown in our eighty-five acres and there is little room for further planting, particularly of large trees. The work of labelling such a large collection presents difficulties and label printers are constantly at work repainting old labels and preparing new ones. The majority of our labels are made of wood or metal, 6" $\times$ 4", with an iron prong 8" long for sticking in the ground. They are painted black with the plant name clearly printed in white. For pots and small species printed aluminium labels are used. These are also attached to trees in the Gardens' jungle, but unfortunately they are often removed by monkeys.

The Herbarium

In addition to the living collection, a botanic garden should have a *hortus siccus*—the herbarium, or at least one reasonably accessible to it. In this, dried mounted specimens are preserved. The Singapore Herbarium is situated in the Gardens and has over 400,000 sheets. The specimens are mainly confined to plants of the Malaysian region, which extends from Sumatra and Malaya to New Guinea, but there are a few from surrounding countries. Our oldest specimens are over 150 years old and are still in a good state of preservation, despite the fact that they are housed in wooden cupboards and the building is not air-conditioned, although the latter is preferred if possible. The collection is arranged according to the Bentham and Hooker system, and, within the species folders, according to the various Malay states, Malay islands and exotics. There is also a smaller and separate Gardens' Herbarium of cultivated plants.

In addition to being in constant use by the botanists, both at the Gardens and the University, the specimens are sent on loan to botanical institutions elsewhere for study. In 1956 a total of 4,525 sheets were sent on loan, mainly to Leiden, Bogor and Kew, to authors of the *Flora Malesiana*, while 4,903 sheets were sent on loan in 1955. The value of the specimens is enhanced considerably when the sheets are returned correctly annotated. Inevitably some mixing occurs in folders until the genus has been currently revised, but this is not peculiar to Singapore.

There is also a good collection of spirit material, particularly of orchids, and this is invaluable for detailed study.

Collecting, naming and distribution of specimens

Both the living and dead collections of plants at the Botanic Gardens are added to constantly by collection, donations and exchange. Plants do not recognize political boundaries and in studying the plants of a country such as Malaya, it is essential to study the plants of surrounding countries, if one is to understand the variation and distribution of the local species. Thus botanists from the Singapore Botanic Gardens, although the bulk of their collection has been made in Malaya, have also collected extensively in Borneo and to a lesser extent elsewhere, where the flora shows regional affinities. We also try to collect as many duplicates as possible of each gathering, so that these may be distributed to other institutions elsewhere. In these uncertain days spacial separation of duplicates is very desirable, so that if one or more sets are destroyed, as happened in Berlin and the Philippines during the war, others are available elsewhere. 5,397 duplicates were distributed from Singapore in 1956, many of which were plants collected by the writer in Sarawak. 6,768 duplicates were received, of which a large portion came from the Forestry Departments of Sarawak, Brunei and British North Borneo. Many of these were unnamed and have since been determined by the staff. Private collectors are also encouraged to send in specimens.

The importance of adequate field data on all specimens cannot be over-stressed. Each specimen should be given a serial number and notes are made of the place of collection, habitat, altitude, relative abundance, as well as information on habit, colour of flowers, etc., which cannot be ascertained from the dried specimens. Special herbarium labels are provided for listing this data. In the past this type of information, which can be of very great value to the taxonomist, was frequently neglected. Sterile material is often of doubtful value.

With the aid of a good modern flora, a botanist should be able to determine most of his specimens in the field—but unfortunately how many tropical countries have complete up-to-date floras! Even when they are available, certainty can only be reached by comparison with authentic named material. Agricultural and forestry departments, teachers, students, planters and others from Malaya, Borneo and elsewhere send us specimens for determination. Small plant fragments are sometimes sent for identification in connection with police investigations, medical enquiries, etc. We receive frequent requests for information on certain plants. Thus we provide an important service, which cannot be obtained elsewhere in Malaya.

Taxonomic studies

A very important function of any botanic gardens is research in systematic botany. This critical and highly specialised work involves detailed revisions of genera and families and is an essential preliminary to the publication of any flora. Previously named species are critically examined, questions of synonymy are finalised, and new species are described. Furthermore such work can never be completely perfected, as a critical study of the great amount of material collected during the past 40 years reveals large numbers of undescribed species, as well as new information on distribution and variability, while future collecting will yield yet more. It is necessary that the names and descriptions of Malayan plants should be brought into line with those of neighbouring countries. I am convinced that a study of Malaysian plants as a whole is an essential preliminary in the preparation of the local flora. Consequently, the staff of the Singapore Botanic Gardens is now collaborating in the production of the *Flora Malesiana*, edited by C. G. G. J. van Steenis of Leiden University and financed by the Indonesian Government.* This major work will occupy many botanists from many countries for many years.

So much new material and new knowledge has accumulated since the publication of Ridley's *Flora of the Malay Peninsula* in 1922–25, that it is now out-of-date and a *Revised Flora of Malaya* is being prepared. Two volumes have been published so far, both by R. E. Holttum, namely, *Orchids of Malaya* (1953) and *Ferns of Malaya* (1955). This work is designed to be of use to the field

* From 1st January, 1958 funds from this source have ceased. The *Flora Malesiana* Foundation is currently sponsored by the Netherlands Organisation for Pure Scientific Research "Z.W.O." with contributions from British Government and Commonwealth sources, including Singapore.

Editor.

naturalist and the gardener, as well as the specialist, and includes introduced, as well as indigenous plants.

The great complexity of the Malaysian flora, which is one of the richest in the world, makes the task of the taxonomist a very formidable one. Some idea of this can be obtained if one realises that the island of Singapore, with an area of 225 square miles and a population of one and a quarter million, has some 2,000 indigenous species of plants, a total which is greater than that of the British Isles; the Malay Peninsula has about 10,000 species, while the estimate for the Malaysian region as a whole is 30,000 species.

The taxonomist working in the region whose flora he is describing has the great advantage of being able to study many of the plants in his group living in their natural habitat, which is an invaluable aid to his study of herbarium material. Some of the plants may also be growing in the local botanic gardens. For modern taxonomic study it is essential for the worker to see as many as possible of all the collections that have ever been made of the species he is studying. Thus most herbaria are willing to lend their specimens to experts wherever the latter may be working.

The importance of taxonomic research

The great Linnaeus has said "Science, and in the first place botany, is the only reliable basis of private as well as national economy." Many people would regard this statement as too sweeping; nevertheless taxonomic research is of vital importance to the agriculturist, the forester and other applied scientists, as well as all those who wish to assess and develop the natural resources of a country. Many people fail to realise the importance of giving plants their correct scientific names, so that their results can be understood in all countries regardless of the language used. Their research would often be of greater value if they took the trouble to ascertain the correct names of the plants they are working with, and, in the case of plants not widely known, would lodge authentic specimens at some recognized institution for reference purposes. Anthropologists and others frequently write of plants used by indigenous people as food and medicine and in magic, etc., and are content to give the vernacular names only, thus rendering their work nearly worthless for the botanist, chemist and others, who might well follow it up had they taken the trouble to collect specimens and get them properly identified. I have long felt that there is far too little active collaboration between the agriculturist and the botanist to their mutual disadvantage.

The knowledge of the correct names of plants is essential for the ecologist. I would like to see the collecting numbers of plants

quoted in ecological papers, so that future workers have access to the specimens of which authors have based their results. Some ecological studies have been carried out by the staff of the Singapore Botanic Gardens in the past and I would like to see this extended. I believe that ecological studies in the widest sense provide the only sound basis for the preparation of rational plans of land utilisation.

Botanists from their collections and research discover plants which are closely related to those in cultivation and thus can provide material of great value to the plant breeder. An Indian sugarcane breeder visited Singapore in 1956 and found in our herbarium one sheet of a variety of *Saccharum spontaneum*, which had been collected by Ridley in 1891 in a remote area of Pahang. Travelling by plane, car and boat he was able to obtain planting material of the variety and returned to Singapore within four days.

This section could be extended considerably. I hope I have said enough to convince the Philistines that the plant collecting and taxonomic research carried out by the staff of the botanic gardens has a wider application than is often realised.

HORTICULTURAL WORK

Exchange of Planting material

Most botanic gardens produce an annual *Index Seminum*, or seeds list, which they distribute to other botanic gardens for favour of exchange. As the number of species of which seed is available in Singapore varies but little from year to year, our list is produced at irregular intervals for distribution and is also available on request. We receive lists from all over the world, including most communist countries. In this way a free exchange of planting material is effected, thus enriching the living collection of plants in all countries. In 1955 the Singapore Botanic Gardens sent out 515 packets of seeds and 113 plants on an exchange basis and received 362 packets of seeds and 371 plants, including gifts. 368 packets of seeds and 87 plants were despatched in 1956, while 575 packets of seeds and 185 plants were received. Only a small proportion of the introductions may be really successful in Singapore; nevertheless, our collection of plants is being added to constantly and new plants of horticultural value are available for the country as a whole.

The immediate supply of seeds from the Singapore list cannot be guaranteed as many local seeds are viable for short periods only and stocks cannot be kept in good condition, while many species fruit at irregular or long intervals. Every effort is made to meet requests, however, and lists are kept of requirements and the seeds



Top—Formal Garden.
Lawn J

Below—Sun Rockery
and Director's Quarters
in background



are collected and despatched at the earliest opportunity as they become available. Our current list gives 864 species, some of which are grown in the Gardens, while others are collected in the natural vegetation on the island. Many of the larger seeds of short viability are sent out in damp powdered charcoal or damp coir dust. Germination begins during transit and we receive very favourable reports on palms and other seeds sent out in this way.

In addition to this normal exchange of seeds between botanical institutions, many requests are received for living plants, as well as spirit and fixed material, from specialists elsewhere. Wherever possible it is provided, except for unreasonable requests which would require a major expedition to fulfil or take up too much time. In all this exchange care is taken to see that only authentic material is sent out.

During the past few years a collection of over 400 species of cacti and other succulents has been built up. These grow surprisingly well in Singapore, provided they are sheltered from the rain and receive plenty of sun. They are grown in open-sided houses with glass roofs. Succulents are becoming very popular among local growers.

Members of the staff on collecting expeditions bring back local plants of horticultural value for trial in the Gardens, while friends and correspondents send in similar material. Living material is usually packed in polythene bags, in which it remains fresh for a considerable period. One of the most successful introductions in recent years has been the New Guinea Creeper (*Mucuna bennettii*), which produces hundreds of large spectacular trusses of brilliant flame-coloured flowers several times a year.

Although most of the work on economic plants has been taken over by the Agricultural and Forestry Departments, there is still a good collection in the Singapore Botanic Gardens and new ones of special interest, such as *Rauwolfia* spp., are introduced for trial.

Breeding of Orchids and Other Plants

The seasonless climate of Singapore, with an average annual rainfall of 105 inches per year, a mean temperate of about 80°F. with little diurnal change and a mean relative humidity of 82 per cent, makes it difficult to find plants which will flower regularly and provide colour in the Gardens. The aspect of the natural vegetation is varying shades of green and offers little in the way of good horticultural plants. Consequently, most of the garden plants grown in Singapore have originated in countries other than Malaya and where there are distinct cold or dry seasons. Under our conditions there is no special season of flowering or leaf-fall and individual

plants of the same species adjust themselves quite differently. Consequently, we never get the spectacular bursts of flowering of such trees as *Delonix regia* or *Jacaranda* as can be seen in India or East Africa.

One of the solutions to this problem is the breeding of new varieties of plants suited to local conditions and this work has been actively pursued at the Singapore Botanic Gardens for many years. Although hybridisation has been done in various groups such as *Bougainvillea*, *Cannas*, etc., by far the most attention has been devoted to orchids. This work was begun in 1929 and has produced very successful and spectacular results. The aid is two-fold, namely, to produce hybrids of horticultural merit and commercial worth and to investigate the relationship between the various groups of orchids. Malaya has some 800 species of indigenous orchids, but only a few of these are suitable for garden plants. By hybridising these, together with imported species from Burma, Java, the Moluccus, New Guinea and the Philippines, a very wide range of free-flowering and beautiful hybrids have and are being produced.

The principal genera used in crossing are: *Arachnis*, *Dendrobium*, *Renanthera*, *Spathoglottis* and *Vanda*. The first Singapore hybrid was *Vanda* Miss Joaquim raised in 1893, but the bulk of the hybrids now grown have been produced in the last 30 years and many of these since the war. Some 2,800 crosses have been made to date and every year new hybrids are coming into bloom. Local growers also make crosses and bring their seeds for raising at the Gardens, while a few have now mastered the technique and raise them themselves.

The seedlings are first grown in conical flasks under sterile conditions. The medium used in Singapore is agar-agar with Vacin's solution and 2 per cent sugar, at a pH of about 5.2. Full details of the method are given by Holttum (1953b). In 1956 experiments were begun using coconut milk (the water inside the mature nut) in the medium and this is giving a considerable stimulus to the early growth of the seedlings. The mature orchids are grown in the open or with slight shade, either in pots or in beds, depending on the type, and details of the cultivation can be found in Holttum (1953b) and Henderson and Addison (1956).

Mention can only be made of one or two of the hybrids raised in Singapore. A fuller account of the principal hybrids, except for the very recent ones, with photographs of a spray and individual flower of each hybrid, has recently been published in Henderson's and Addison's *Malayan Orchid Hybrids* (1956). *Vanda* Tan Chay

Yan, which first flowered in 1952, was awarded a First Class Certificate of the Royal Horticultural Society at the Chelsea Flower Show in 1954 and is considered to be one of the best *Vanda* hybrids bred anywhere in the world. *Arachnis* Maggie Oei, now one of the principal cut flowers in Singapore, flowers continuously, whereas its larger parent *A. flosaeris* flowers but twice a year. Among the inter-generic hybrids bred in Singapore are *Aranda* (*Arachnis* $\times$ *Vanda*), *Aranthera* (*Arachnis* $\times$ *Renanthera*) *Renantanda* (*Renanthera* $\times$ *Vanda*), while our first tri-generic hybrid flowered in 1956 and has been named *Ridleyara* Fascad, in honour of H. N. Ridley. Mr. Ridley was informed of this shortly before his death.

There are a large number of enthusiastic orchid growers in Singapore and the Federation and there is a considerable demand for plants and seedlings grown in the Gardens. The sale of cut orchids, both local and for export, is rapidly increasing. An experienced cytogeneticist is expected to visit Singapore shortly to work on problems of orchid hybridization.

Sale of Plants

Although the sale of plants is not an essential function of a botanic gardens, it is desirable in those countries where there are few nurseries. The Singapore Botanic Gardens sells plants daily, but limits the sales to those plants which are not readily available in the local nurseries. The revenue from the sale of plants in 1956 was \$27,245 (Straits), of which the major share came from the sale of 3,446 orchid plants and seedlings, while 26,092 other plants were also sold.

Advisory Work

The horticultural staff of the Singapore Botanic Gardens advise and assist various government departments in planning the lay-out and planting of roadsides, open spaces, school compounds, etc., and usually supply free material for this purpose. They also maintain close contact with the City Council Parks Department and many requests for advice are also received from private firms and individuals. Thus the Gardens play a large part in beautifying the city and island.

Men from the Rehabilitation Centre of the Labour Department are accepted for training as gardeners. The Director of the Singapore Botanic Gardens is the Imperial War Graves Commissioner's representative in Singapore and the staff of the Gardens take charge of the care and maintenance of the Kranji War Cemetery.

EDUCATIONAL WORK

General

The maintenance of a large, named and labelled collection of local and introduced plants attractively laid-out in the Botanic Gardens enables all visitors, who are interested, to increase their knowledge of plants. Parties of school children and students, both from Singapore and the Federation pay regular visits to the Gardens and occasionally parties are taken round by members of the staff. Special exhibits are arranged from time to time. One which proved popular with teachers and students was an exhibit of seven common plants which were changed weekly. The plants were labelled with their scientific, English and Malay names and family and brief notes were appended. Members of the staff are often requested to give lectures to local societies, a valuable method of educating the public in our work.

The staff of the Gardens co-operates fully with the staff of the University of Malaya's Department of Botany. The University is adjacent to the Gardens and so the latter are very handy for lecturers and students who wish to use them, while much material is provided for class work and research.

Singapore Gardening Society

The staff of the Singapore Botanic Gardens was largely responsible for the founding of the local Gardening Society, which at present has about 250 members. An active interest is taken in its work, as well as that of the Malayan Orchid Society. Some monthly meetings are held at the Gardens and emphasis is usually placed on practical demonstrations. A very successful annual flower show is held and the standard of blooms and plants exhibited is high. In these ways, the interest of local horticulturists is stimulated and the standard of gardening is raised.

PUBLICATIONS AND LIBRARY

It is very desirable that botanic gardens carrying out research should have their own journal for the publication of their results. Ridley founded the *Agricultural Bulletin of the Malay Peninsula* in 1891. The title was changed to the *Agricultural Bulletin of the Straits and Federated Malay States* in 1900 and it was then issued monthly. This journal was largely devoted to work on economic plants. Ridley published many taxonomic papers in the journal of the *Royal Asiatic Society, Straits Branch*, of which he was editor from 1889 to 1911, as well as being secretary of the Society. The title of the *Agricultural Bulletin* was changed in 1913 to the *Gardens' Bulletin, Straits Settlement* and in 1947 to the *Gardens'*

Vol. XVII. (1958).

Bulletin, Singapore. This is published at irregular intervals and an attempt is now made to produce a volume per year. It is largely devoted to papers on local taxonomy. It is distributed to the major botanical institutions in the world and exchange arrangements now exist with 160 scientific bodies. It can also be purchased direct from the Botanic Gardens, Singapore. In exchange we receive valuable periodicals and reprints, which are so essential for our work, and which we would not be able to purchase from our slender library vote. The *Annual Report* is also printed and distributed.

In addition to these and other publications already referred to in this article, the Gardens staff prepares from time to time more popular works which are of general interest to the amateur. Such a work is Henderson's *Malayan Wild Flowers* (1949-54) published by the Malayan Nature Society. A series of small illustrated pamphlets, each containing drawings and brief descriptions of ten *Malayan Garden Plants* are also produced. Popular horticultural articles are submitted regularly to the *Malayan Agri-Horticultural Journal* and the *Malayan Orchid Journal*. Names and descriptions of our new orchid hybrids are published in the latter.

Adequate library facilities are essential for the research workers at botanic gardens. The taxonomist must consult original publications for the names and descriptions of the plants on which he is working, and for this the older, as well as modern literature is required. The Singapore Botanic Gardens are particularly fortunate in that they have one of the finest collections of old botanical books in South-East Asia, many of which are of considerable value and rarity. In all, the library contains some 8,000 bound volumes, as well as many periodicals.

Since 1890 there has always been an artist on the Gardens' staff, who prepares drawings and paintings for the specialist staff. The paintings done by James and Charles de Alwis between 1890 and 1908 are of outstanding beauty and accuracy and are among the treasured possessions of the Singapore Botanic Gardens. Over the years a large and valuable collection of plant drawings and paintings has been built up.

NATURE RESERVES

I have already shown how Cantley and Ridley were responsible for gazetting and maintaining the first forest reserves in the Straits Settlement. These were later taken over by the Forest Department. The Singapore forest reserves reverted to the control of the Botanic Gardens in 1937 and have since been maintained as nature reserves. Under the *Nature Reserves Ordinance* of 1951, some 8,000

acres in Singapore were "set aside for the purpose of the propagation, protection and preservation of the indigenous fauna and flora of the Colony", as well as "providing, under suitable conditions and control, facilities for the study of and research into matters relating into the fauna and flora and the physical conditions in which they live". The reserves are administered by a statutory board of management of six nominated trustees, with the Director of the Botanic Gardens as *ex-officio* chairman. The day-to-day administration is carried out by the staff of the Singapore Botanic Gardens.

Inevitably, with the spread of the rapidly increasing population, plants and animals, which were known to have occurred in Singapore, have disappeared completely. Every effort is being made to preserve the remnants which are left for present and future generations to study and enjoy. Only a comparatively small area of the nature reserves consists of primary vegetation. The most important is undoubtedly the Bukit Timah Reserve covering 163 acres on the highest hill on the island. It has been a botanical collecting ground for more than a century, and it is the type locality of many Malayan plants. It consists of primary tropical evergreen rain forest, with many trees 50–70 m. high, and for the greater part it has not been cut over nor damaged. There are also important areas of mangrove on the south coast preserved as a nature reserve.

Thus the Botanic Gardens have guarded jealously this heritage of the people, which might so easily have been lost for ever.

THE FUTURE

And what of the future? Singapore is shortly to receive independence. Already the Government has embarked upon a programme of rapid Malayanisation of its staff, although it is not likely that this will be fully achieved at the Gardens as rapidly as in some other departments. A local man has returned from training as a horticulturist at the Royal Botanic Gardens, Kew, while botanists and others are to be sent overseas for further training and on their return will take over from the expatriate officers. Much will depend on these new recruits to maintain the Gardens and collections and to carry on the tradition of research which has been built up during the past hundred years. It is hoped that the scheme recently devised to attract research workers from Britain and elsewhere to Singapore to carry out botanical research in their specialised fields will be continued and extended.

The Gardens are financed entirely by the Singapore Government and now come under the Ministry of the Chief Secretary.* In the

* In 1959 the Gardens came under the newly formed Ministry of National Development.

1957 estimates a total of \$546,780 (=£63,791) is voted to the Gardens and this includes the votes for the upkeep of Government House Domain and the Nature Reserves. If they are to survive, it will be necessary to convince the politicians and the general public that the Gardens are fulfilling a worthwhile rôle, not only as a public park, but also that the research carried out is of value to the economy and prestige of Singapore. As Commelijn said in 1701 (de Wit, 1949) "It is certain, however, that this Science, like all Sciences, flourishes sometimes more and sometimes less, all in accord with the inclination of Rulers and the Favour of Government."

A recent distinguished visitor wrote in my visitor's book "The Singapore Botanic Gardens are unique. Civilisation would be the poorer if they were not maintained." In discussing the history of botanic gardens in the tropics, I have shown how many of them were neglected or abandoned and failed in their primary function, which is the scientific study of plants. New botanic gardens are being founded at some of the new tropical universities and university colleges, but it will take them many, many years to build up the type of collection of living and herbarium specimens which is now available in Singapore. It is my fervent hope that the Singapore Botanic Gardens may be fully maintained for many long years to come and to continue as a leading centre of tropical botany and a worthy memorial to Ridley and those other members of the staff who have helped to raise them to their present position.

I have shown how in these uncertain and unsettled days there still exists much goodwill and active co-operation between botanic gardens, wherever they may be situated. As Baas Becking says in the Preface to *Flora Malesiana* "as long as sentiment, politics, greed and bigotry rule this world, a purely scientific endeavour may become a binding force between individual groups, and maybe, even between nations". If the aims and ideals which motivate the work of botanic gardens could be extended to certain other fields of human endeavour we could make this planet a better place on which to live.

ACKNOWLEDGEMENTS

In addition to the works quoted in the bibliography, reference has been made to all the published *Annual Reports* of the Botanic Gardens Department, Singapore from 1875 to the present day, as well as unpublished data in the files of the Department.

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